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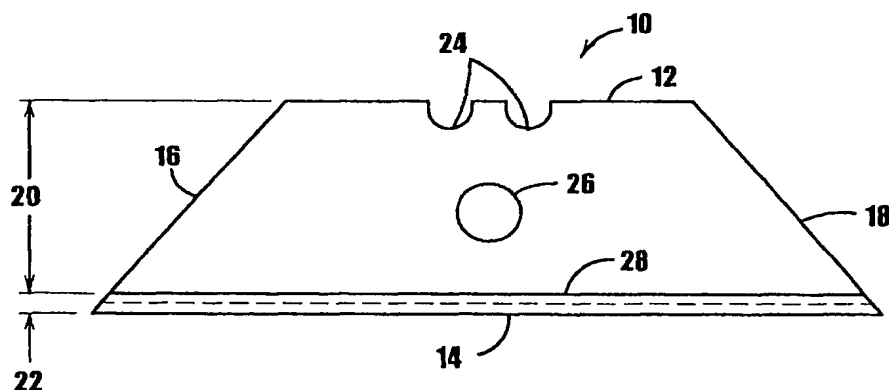
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(54) Title: COMPOSITE UTILITY KNIFE BLADE, AND METHOD OF MAKING SUCH A BLADE



(57) Abstract: A composite utility knife blade (10) and method of making such a blade involves butt joining a tool steel wire (44) to a front edge of an alloy steel backing strip (34). The wire (44) is electron beam welded to the backing strip (34) to form a composite strip (46) defining a first metal portion (20) formed by the alloy steel backing strip (34), a second metal portion (22) formed by the tool steel wire (44), and a weld region (28) joining the first and second metal portions (20, 22). The composite strip (46) is then annealed, and the annealed strip is straightened to eliminate any camber therein. The annealed composite strip (46) is then hardened such that the first metal portion (20) defines a surface hardness within the range of approximately 38 Rc to approximately 52 Rc, and the second metal portion (22) defines a surface hardness within the range of approximately 60 Rc to approximately 75 Rc.

WO 03/009978 A1

WO 03/009978

PCT/US02/23800

**COMPOSITE UTILITY KNIFE BLADE,
AND METHOD OF MAKING SUCH A BLADE**

Field of the Invention

5 The present invention relates to utility knife blades, and more particularly; to composite utility knife blades wherein the outer cutting edge of the blade is made of a highly wear-resistant alloy, and a backing portion of the blade is made of an alloy selected for toughness, such as spring steel. The present invention also relates to methods of making such composite utility knife blades.

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Background Information

Conventional utility knife blades are made of carbon steel and define a back edge, a cutting edge located on an opposite side of the blade relative to the back edge, and two side edges located on opposite sides of the blade relative to each other and extending between
15 the back and cutting edges of the blade. A pair of notches are typically formed in the back edge of the blade for engaging a locator in a blade holder. Typically, the back, cutting and side edges of the blade define an approximately trapezoidal peripheral configuration.

Conventional utility knife blades are manufactured by providing a carbon steel strip, running the strip through a punch press to punch the notches at axially spaced locations on
20 the strip, and stamping a brand name, logo or other identification thereon. Then, the strip is scored to form a plurality of axially spaced score lines, wherein each score line corresponds to a side edge of a respective blade and defines a preferred breaking line for later snapping the scored strip into a plurality of blades. The punched and scored strip is then wound again into a coil, and the coil is hardened and tempered. The hardening and tempering operations
25 may be performed in a "pit-type" vacuum furnace wherein the coils are repeatedly heated and cooled therein. Alternatively, the hardening and tempering operations may be performed "inline", wherein the strip is unwound from the coil and successively driven through a series of furnaces and quenching stations to harden and temper the strip. The carbon steel strip is typically heat treated to a surface hardness of about 58 Rockwell "c" ("Rc"), and thus defines a relatively hard and brittle structure.
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The heat treated strip is then ground, honed and stropped in a conventional manner to form the facets defining a straight cutting edge along one side of the strip. Then, the strip is snapped at each score line to, in turn, break the strip along the score lines and thereby

WO 03/009978

PCT/US02/23800

form from the strip a plurality of trapezoidal shaped utility knife blades. Because the entire strip is relatively hard and brittle (about 58 Rc), the strip readily breaks at each score line to thereby form clean edges at the side of each blade.

One of the drawbacks associated with such conventional utility knife blades is that each blade is formed of a single material, typically carbon steel, that is heat treated to a relatively hard and brittle state, typically about 58 Rc. Thus, although such blades define a relatively hard, wear-resistant cutting edge, the entire blade is also relatively brittle, and therefore is subject to premature breaking or cracking in use. In addition, the cutting edges of such conventional blades are frequently not as wear resistant as might otherwise be desired. However, because the entire blade is made of the same material, any increase in hardness, and thus wear resistance of the cutting edge, would render the blade too brittle for practical use. As a result, such conventional utility knife blades are incapable of achieving both the desired wear resistance at the cutting edge, and overall toughness to prevent cracking or premature breakage during use. Another drawback of such conventional utility knife blades is that the carbon steel typically used to make such blades corrodes relatively easily, thus requiring premature disposal of the blades and/or costly coatings to prevent such premature corrosion.

Certain prior art patents teach composite utility knife blades defining sandwiched, laminated, or coated constructions. For example, U.S. Patent No. 4,896,424 to Walker shows a utility knife having a composite cutting blade formed by a body section 16 made of titanium, and a cutting edge section 18 made of high carbon stainless steel and connected to the body section by a dovetail joint 25.

U.S. Patent Nos. 3,279,283, 2,093,874, 3,681,846, and 6,105,261 relate generally to laminated knives or razor blades having cutting edges formed by a core layer made of a high carbon steel or other relatively hard material, and one or more outer layers made of relatively softer materials. Similarly, U.S. Patent Nos. 3,911,579, 5,142,785, and 5,940,975 relate to knives or razor blades formed by applying a relatively hard carbon coating (or diamond like coating ("DLC")) to a steel substrate. In addition, U.S. Patent Nos. 5,317,938 and 5,842,387 relate to knives or razor blades made by etching a silicon substrate.

One of the drawbacks associated with these laminated, sandwiched and/or coated constructions, is that they are relatively expensive to manufacture, and therefore have not achieved widespread commercial use or acceptance in the utility knife blade field.

WO 03/009978

PCT/US02/23800

In stark contrast to the utility knife blade field, bi-metal band saw blades have been used in the saw industry for many years. For example, U.S. Reissue Patent No. 26,676 shows a method of making bi-metal band saw blades wherein a steel backing strip and high speed steel wire are pre-treated by grinding and degreasing, and the wire is welded to the backing strip by electron beam welding. Then, the composite band stock is straightened and annealed. The sides of the annealed stock are then dressed, and the band saw blade teeth are formed in the high speed steel edge of the composite stock by milling. Then, the teeth are set and the resulting saw blade is heat treated. There are numerous methods known in the prior art for heat treating such band saw blades. For example, International Published Patent Application No. WO 98/38346 shows an apparatus and method for in-line hardening and tempering composite band saw blades wherein the blades are passed around rollers and driven repeatedly through the same tempering furnace and quenching zones. The heat treated composite band saw blades are then cleaned and packaged.

Although such bi-metal band saw blades have achieved widespread commercial use and acceptance over the past 30 years in the band saw blade industry, there is not believed to be any teaching or use in the prior art to manufacture utility knife blades defining a bi-metal or other composite construction as with bi-metal band saw blades. In addition, there are numerous obstacles preventing the application of such band saw blade technology to the manufacture of utility knife blades. For example, as described above, conventional utility knife blades are manufactured by forming score lines on the carbon steel strip, and then snapping the strip along the score lines to break the strip into the trapezoidal-shaped blades. However, the relatively tough, spring-like backing used, for example, to manufacture bi-metal band saw blades, cannot be scored and snapped in a conventional way. Rather, such relatively tough materials require different processes to form the utility knife blades from a heat treated, composite strip. In addition, the heat treating applied to conventional utility knife blades could not be used to heat treat bi-metal or other composite utility knife blades.

Accordingly, it is an object of the present invention to overcome one or more of the above-described drawbacks and disadvantages of prior art utility knife blades and methods of making such blades, and to provide a bi-metal or other composite utility knife blade defining a relatively hard, wear-resistant cutting edge, and a relatively tough, spring-like backing, and a method of making such utility knife blades.

WO 03/009978

PCT/US02/23800

Summary of the Invention

The present invention is directed to a composite utility knife blade comprising a back edge, a cutting edge located on an opposite side of the blade relative to the back edge, and two side edges located on opposite sides of the blade relative to each other and
5 extending between the back and cutting edges of the blade. In a currently preferred embodiment of the present invention, the back, cutting and side edges of the blade define an approximately trapezoidal peripheral configuration. The composite utility knife blade of the present invention further defines first and second metal portions, wherein the first metal portion extends between the back edge and the second metal portion, and further extends
10 from approximately one side edge to the other side edge of the blade. The first metal portion is formed of an alloy steel heat treated to a hardness within the range of approximately 38 Rc to approximately 52 Rc. The second metal portion defines the cutting edge, and extends from approximately one side edge to the other side edge, and is formed of a high speed or tool steel heat treated to a hardness within the range of approximately 60 Rc
15 to approximately 75 Rc. A weld region of the blade joins the first and second metal portions and extends from approximately one side edge to the other side edge of the blade.

The present invention is also directed to a method of making composite utility knife blades. The method comprises the steps of providing an elongated wire formed of high speed or tool steel, and an elongated backing strip formed of an alloy steel and defining an
20 approximately planar upper side, an approximately planar lower side, and opposing back and front edges extending between the upper and lower sides. The wire is butt joined to the front edge of the backing strip. Then, thermal energy is applied to the interface between the wire and backing strip to weld the wire to the backing strip and, in turn, form a composite strip defining a first metal portion formed by the steel backing strip, a second metal portion
25 formed by the high speed steel wire, and a weld region joining the first and second metal portions. The composite strip is then annealed, and the annealed strip is straightened to eliminate any camber or other undesirable curvatures in the annealed composite strip. Then, a plurality of notches are formed, such as by punching, in axially spaced locations relative to each other along the back edge of the first metal portion and/or at other desired locations
30 of the annealed composite strip. The annealed and punched composite strip is then hardened such that the first metal portion defines a surface hardness within the range of approximately 38 Rc to approximately 52 Rc, and the second metal portion defines a surface hardness within the range of approximately 60 Rc to approximately 75 Rc. The

WO 03/009978

PCT/US02/23800

hardened strip is then subjected to at least one, and preferably two, tempering and quenching cycles. Then, facets are formed on the edge of the second metal portion, such as by grinding, honing and stropping, to in turn form an approximately straight, high speed or tool steel cutting edge along the side of the composite strip opposite the back edge of the first metal portion. The composite strip is then die cut, bent and snapped, or otherwise separated along shear or score lines axially spaced relative to each other to form a plurality of utility knife blades from the strip. In a currently preferred embodiment of the present invention, each utility knife blade defines an approximately trapezoidal peripheral configuration and at least one notch is formed in the back edge thereof.

In accordance with an alternative embodiment of the present invention, prior to hardening, the high speed or tool steel edge of the composite strip is cut to form notches, such as by punching, at the interface of each shear or score line and the second metal portion. The notches are formed to separate the high speed steel cutting edges of adjacent composite utility knife blades formed from the composite strip, to facilitate bending and snapping the blades from the composite strip, and/or to shape the corners of the cutting edges of the blades.

In accordance with another embodiment of the present invention, the composite strip is scored at axially spaced locations relative to each other to form a plurality of score lines, wherein each score line is oriented at an acute angle relative to the back edge of the first metal portion, and the plurality of score lines define a plurality of blade sections and scrap sections located between the blade sections. In the trapezoidal blade configuration, the scrap sections are approximately triangular and the blade sections are approximately trapezoidal. As described above, notches are preferably formed at the interface of each score line and the second metal portion to facilitate separation of the blades from the composite strip and to shape the corners of the cutting edges of the blades. In order to separate the blades from the composite strip, each scrap section is bent outwardly relative to a plane of the composite strip on one side of a respective score line. Upon bending each scrap section, the composite strip is pressed on an opposite side of the respective score line to, in turn, break the blade section away from the bent scrap section along the respective score line. This process is repeated at each score line, or is performed substantially simultaneously for each pair or other group of score lines defining each respective utility knife blade, to thereby form the plurality of blades from the composite strip.

WO 03/009978

PCT/US02/23800

One advantage of the utility knife blades of the present invention, is that they provide an extremely hard, wear-resistant cutting edge, and an extremely tough, spring-like backing, particularly in comparison to the conventional utility knife blades as described above. Thus, the utility knife blades of the present invention provide significantly improved blade life, and cutting performance throughout the blade life, in comparison to conventional utility knife blades. In addition, the utility knife blades, and methods of making such blades, are relatively cost effective, particularly in comparison to the composite utility knife blades defining sandwiched, laminated and/or coated constructions, as also described above. As a result, the utility knife blades of the present invention provide a combination of wear resistance, toughness, cutting performance, and cost effectiveness heretofore believed to be commercially unavailable in utility knife blades.

Other objects and advantages of the present invention will become readily apparent in view of the following detailed description of preferred embodiments and accompanying drawings.

Brief Description of the Drawings

FIG. 1 is a top plan view of a composite utility knife blade embodying the present invention;

FIG. 2 is partial, end elevational view of the composite utility knife blade of FIG. 1 showing the multi-faceted cutting edge of the blade.

FIGS. 3A and 3B are flow charts illustrating conceptually the procedural steps involved in the method of making the composite utility knife blades of the present invention.

FIG. 4 is a somewhat schematic, perspective view of an apparatus for welding a high speed steel wire to a spring-steel backing to form bi-metal utility knife blades in accordance with the present invention.

FIG. 5 is a somewhat schematic, perspective view of an apparatus for scoring and punching bi-metal strips in order to make bi-metal utility knife blades in accordance with the present invention.

FIG. 6 is a somewhat schematic, perspective view of an apparatus for die cutting bi-metal strips in accordance with the present invention.

WO 03/009978

PCT/US02/23800

FIG. 7 is a somewhat schematic, perspective view of an apparatus for punching notches in the high-speed or tool steel edges of the bi-metal strips prior to hardening the strips in accordance with the present invention, and the resulting notched strip.

FIG. 8 is a somewhat schematic, top plan view of an apparatus for bending and snapping the composite strips in order to make the composite utility knife blades in accordance with an alternative method of the invention. . . .

FIG. 9 is a partial cross-sectional view of the bending and snapping apparatus taken along line 9-9 of FIG. 8.

FIG. 10 is a side elevational view of a composite bi-metal strip that further illustrates in broken lines the bending pins and breaking punches of the bending and snapping apparatus of FIGS. 8 and 9 that operate on the composite strip to form the composite utility knife blades of the present invention.

FIGS. 11A-11D are top plan views of the composite utility knife blade of the present invention illustrating exemplary shapes and configurations that the utility knife blade may take.

Detailed Description of the Preferred Embodiments

In FIG. 1, a composite utility knife blade embodying the present invention is indicated generally by the reference numeral 10. The utility knife blade 10 defines a back edge 12, a cutting edge 14 located on an opposite side of the blade relative to the back edge, and two side edges 16, 18 located on opposite sides of the blade relative to each other and extending between the back and cutting edges of the blade. As shown typically in FIG. 1, in the currently preferred embodiment of the present invention, the back, cutting and side edges of the blade preferably define an approximately trapezoidal peripheral configuration. However, as described further below with reference to FIGS. 11A-11D, the utility knife blade of the present may take any of numerous different shapes or configurations that currently or later become known, including, for example, a square or parallelogram shape, and/or any desired shape with squared, rounded or oblique cutting corners.

The blade 10 further defines a first metal portion 20 and a second metal portion 22. As shown typically in FIG. 1, the first metal portion 20 extends between the back edge 12 and the first metal portion 22, and further extends from approximately one side edge 16 to the other side edge 18. In accordance with the present invention, the first metal portion 20 is formed of a steel, typically referred to as an "alloy" steel, that is heat treated to a surface

WO 03/009978

PCT/US02/23800

hardness within the range of approximately 38 Rockwell "c" (referred to herein as "Rc") to approximately 52 Rc. The second metal portion 22 defines the cutting edge 14 and extends from approximately one side edge 16 to the other side edge 18. In accordance with the present invention, the second metal portion 22 is formed of a steel, typically referred to as a

5 "high speed" or "tool" steel, that is heat treated to a surface hardness within the range of approximately 60 Rc to approximately 75 Rc.

The first metal portion 20 defines a spring-like backing that is relatively pliable, tough, and thus highly resistant to fatigue and cracking. The second metal portion 22, on the other hand, is relatively hard and highly wear resistant, and thus defines an ideal,

10 long-lasting cutting blade. As a result, the composite utility knife blades of the present invention define highly wear-resistant, long-lasting cutting edges, combined with virtually unbreakable or shatter-proof backings. Thus, in stark contrast to the typical utility knife blades of the prior art, the composite utility knife blades of the present invention provide a cost-effective blade exhibiting both improved wear resistance and toughness heretofore

15 commercially unavailable in such blades.

The first metal portion 20 of blade 10 is preferably made of any of numerous different grades of steel capable of being heat treated to a surface hardness within the preferred range of approximately 38 Rc to approximately 52 Rc, such as any of numerous different alloy steels or standard AISI grades, including without limitation 6135, 6150 and

20 D6A. The second metal portion 22, on the other hand, is preferably made of any of numerous different types of wear-resistant steel capable of being heat treated to a surface hardness within the preferred range of approximately 60 Rc to approximately 75 Rc, including any of numerous different tool steels or high-speed steels, such as any of numerous different standard AISI grades, including, without limitation, M Series grades,

25 such as M1, M2, M3, M42, etc., A Series grades, such as A2, A6, A7 A9, etc., H Series grades, such as H10, H11, H12, H13, etc., T Series grades, such as T1, T4, T8, etc., and W, S, O, D and P Series grades.

As may be recognized by those skilled in the pertinent art based on the teachings herein, the currently preferred materials used to construct the first and second metal portions

30 20 and 22 and disclosed herein are only exemplary, and numerous other types of metals that are currently or later become known for performing the functions of the first and/or second metal portions may be equally employed to form the composite utility knife blades of the present invention.

WO 03/009978

PCT/US02/23800

As further shown in FIG. 1, each composite utility knife blade 10 defines a pair of cut outs or notches 24 formed in the back edge 12 and laterally spaced relative to each other. As shown typically in FIG. 1, each notch 24 defines a concave, approximately semi-circular profile, and is provided to engage a corresponding locator mounted within a blade holder (not shown) in order to retain the blade in the blade holder. As may be recognized by those skilled in the pertinent art based on the teachings herein, the notches 24 may take any of numerous different shapes and/or configurations in any of numerous different locations, and the blade may include any number of such notches or other recesses that are currently or later become known to those skilled in the pertinent art for performing the function of engaging a blade holder, or the blade actuating mechanism or locator of such a holder.

As also shown in FIG. 1, the blade 10 further defines a registration aperture 26 extending through the first metal portion in an approximately central portion of the blade. As described further below, the registration aperture 26 is provided to receive a blade positioning device to position the blade in a die, in a blade bending and snapping apparatus, or other blade forming device used during the process of making the blades in accordance with the present invention. As may be recognized by those skilled in the pertinent art based on the teachings herein, the aperture 26 may take any of numerous different shapes or configurations, and the blade may include any number of such apertures or other structural features for performing the function of properly positioning the blade in a die or other manufacturing apparatus. In addition, the registration aperture(s) 26 may be located in any of numerous different locations on the utility knife blade, or may be located within the scrap material adjacent to the blade and within the bi-metal strip from which the blade is formed.

As further shown in FIG. 1, the blade 10 defines a weld region 28 formed between the first and second metal portions 20 and 22, respectively, and defining an approximate line of joinder extending from one side edge 16 to the other side edge 18. As described in further detail below, the second metal portion is joined to the first metal portion 20 by applying thermal energy to the interface, such as by electron beam welding, to thereby weld the first metal portion to the second metal portion and form a resulting weld region defining a line of joinder between the two different metal portions.

As also shown in FIG. 1, the cutting edge 14 defines an approximately straight cutting edge extending from one side edge 16 to the other side edge 18. As shown in FIG. 2, the cutting edge 14 preferably defines first facets 30 located on opposite sides of the

WO 03/009978

PCT/US02/23800

blade relative to each other, and second facets 32 spaced laterally inwardly and contiguous to the respective first facets 30. As shown typically in FIG. 2, the first facets 30 define a first included angle "A", and the second facets 32 define a second included angle "B".

Preferably, the second included angle B is less than the first included angle A. In the currently preferred embodiment of the present invention, the first included angle A is approximately 26° and the second included angle B is approximately 18°. However, as may be recognized by those skilled in the pertinent art based on the teachings herein, these included angles are only exemplary and may be set as desired depending upon the physical properties and/or proposed applications of the blade. As may be further recognized by those skilled in the pertinent art, the utility knife blades of the present invention may include any number of facets.

Turning to FIGS. 3A and 3B, a method of making the composite utility knife blades of the present invention is hereinafter described in further detail. As shown at steps 100 and 102, the backing steel forming the first metal portion 20 and the high speed or tool steel wire forming the second metal portion 22 are cleaned and otherwise prepared for welding in a manner known to those of ordinary skill in the pertinent art. As shown in FIG. 4, the backing steel is preferably provided in the form of one or more continuous elongated strips 34 wound into one or more coils. Each backing strip 34 defines an approximately planar upper side 36, an approximately planar lower side 38, and opposing back and front edges 40 and 42, respectively. Similarly, the high speed steel wire is preferably provided in the form of one or more continuous lengths of wire 44 wound into one or more coils.

At step 104 of FIG. 3A, the high speed or tool steel wire 44 is butt joined to the front edge 42 of the backing strip 34, and thermal energy is applied to the interface between the wire and the backing strip to, in turn, weld the wire to the backing strip and form a bi-metal or composite strip 46 defining the first metal portion 20 formed by the steel backing strip 34, the second metal portion 22 formed by the high speed steel wire 44, and the weld region 28 joining the first and second metal portions. As shown in FIG. 4, a typical welding apparatus 48 includes opposing rollers 50 laterally spaced relative to each other for butt joining the high speed steel wire 44 to the front edge 42 of the backing strip 34, and rotatably driving the composite or bi-metal strip 46 through the welding apparatus. A thermal energy source 52 is mounted within the welding apparatus 48 and applies thermal energy to the interface of the high speed steel wire 44 and front edge 42 of the backing strip to weld the wire to the backing strip. In the currently preferred embodiment of the present

WO 03/009978

PCT/US02/23800

invention, the thermal energy source 52 transmits an electron beam 54 onto the interface of the high speed steel wire and backing strip to electron beam weld the wire to the backing strip. However, as may be recognized by those skilled in the pertinent art based on the teachings herein, any of numerous other energy sources and/or joining methods that are currently or later become known for performing the functions of the electron beam welding apparatus may be equally employed in the method of the present invention. For example, the energy source for welding the high speed steel wire to the backing strip may take the form of a laser or other energy source, and welding processes other than electron beam welding may be equally used.

As shown at step 106 of FIG. 3A, after welding the wire to the backing strip, the bi-metal strip 46 may then be coiled for annealing and/or for transporting the strip to an annealing station. As shown at step 108, the bi-metal strip 46 is annealed in a manner known to those of ordinary skill in the pertinent art. Typically, the bi-metal strips 46 are annealed in a vacuum furnace of a type known to those of ordinary skill in the pertinent art wherein a plurality of coils are vertically mounted relative to each other on a thermally conductive rack, and the rack is mounted in an evacuated furnace to soak the coils at a predetermined annealing temperature for a predetermined period of time. In the currently preferred embodiment of the present invention, the bi-metal strips 46 are annealed at a temperature within the range of approximately 1400° F to approximately 1600° F for up to approximately 5 hours. Then, the heated coils are allowed to cool at a predetermined rate in order to obtain the desired physical properties. For example, the coils may be cooled within the evacuated furnace initially at the rate of about 50° F per hour until the coils reach approximately 1000° F, and then the coils may be allowed to cool at a more rapid rate. As may be recognized by those skilled in the pertinent art based on the teachings herein, these temperatures and times are only exemplary, however, and may be changed as desired depending upon any of numerous different factors, such as the particular materials, constructions and/or dimensions of the bi-metal strip 46, the type of welding process used to weld the wire to the backing, and/or the desired physical properties of the resulting blades.

After annealing, the bi-metal strip 46 is then uncoiled, if necessary, as shown at step 110, and the strip is straightened, as shown at step 112. After welding and annealing, the bi-metal strip 46 may develop a significant camber or other undesirable curvatures, and therefore such curvatures must be removed prior to further processing. In the currently preferred embodiment of the present invention, the bi-metal strip 46 is mechanically

WO 03/009978

PCT/US02/23800

straightened by passing the strip through a series of pressurized rolls in a straightening apparatus of a type known to those of ordinary skill in the pertinent art, such as the Bruderer™ brand apparatus. However, as may be recognized by those skilled in the pertinent art based on the teachings herein, any of numerous straightening apparatus that are currently or later become known for performing the function of straightening metal articles like the bi-metal strip 46 may be equally employed. For example, as an alternative to the mechanical straightening apparatus, the bi-metal strip 46 may be straightened by applying heat and tension thereto in a manner known to those of ordinary skill in the pertinent art.

As shown at step 114, the straightened bi-metal strip 46 may be coiled again, if necessary, for transportation and further processing. As shown at step 116 of FIG. 3B, the annealed and straightened bi-metal strip 46 is then uncoiled, if necessary. At step 118, the bi-metal strip is punched to form a plurality of notches or other cut outs 24 axially spaced relative to each other along the back edge 40 of the annealed bi-metal strip, and is scored to form a plurality of score lines defining the side edges 16 and 18 of each blade. As shown in FIG. 5, a typical apparatus for performing the punching and scoring operations on the bi-metal strip 46 is indicated generally the reference numeral 56. The apparatus 56 includes a scoring tool or instrument 58 mounted on a support 60 above a work support surface 62 supporting the bi-metal strip 46 thereon. As indicated by the arrows in FIG. 5, the scoring instrument is movable vertically into and out of engagement with the bi-metal strip, and may be movable laterally relative to the strip. Thus, as shown typically in FIG. 5, the scoring tool 58 is controlled to engage the upper surface 36 of the bi-metal strip and move into and/or laterally across the strip to, in turn, score the upper surface of the strip and thereby form a plurality of score lines 64 axially spaced relative to each other on the strip and each defining a side edge 16 or 18 of a respective utility knife blade 10 (FIG. 1). As may be recognized by those skilled in the pertinent art based on the teachings herein, the scoring instrument may take any of numerous configurations that are currently, or later become known for performing the function of scoring the composite strip as described herein. For example, a progressive die may be employed to punch the registration aperture 26 for each blade. Then, the same progressive die may either simultaneously or sequentially form the notches 24, 98 in the back and/or cutting edges of each blade and form the score lines 64. The term score line is used herein to mean a line defined by a recess or indentation in the surface of the composite strip. Such lines can be formed by any of numerous instruments or tools that are currently or later become known.

WO 03/009978

PCT/US02/23800

In accordance with a currently preferred embodiment of the present invention, the depth of score is preferably within the range of about 40% to about 50% of the thickness of the blade, and most preferably within the range of about 45% to about 48% of the thickness of the blade. In the illustrated embodiment, the blade is approximately 0.6 mm thick, and the depth of score is preferably within the range of about 0.27 mm to about 0.29 mm. With the current blade design and materials of construction, a depth of score greater than about 50% of the blade thickness has tended to cause the bi-metal strip to pull apart at the score lines upon passage through the furnace. Also in accordance with the currently preferred embodiment of the present invention, each score line is approximately v-shaped, and the included angle of each v-shaped score line is preferably within the range of about 50° to about 60°. In the illustrated embodiment of the present invention, the included angle of each score line is about 55°. The greater the included angle of the score line, the greater is the pressure on the back side of the blade upon scoring, and thus the greater is the likelihood that the scoring tool will create a ripple effect on the back side of the blade. The smaller the included angle, on the other hand, the more rapid will be the scoring tool wear during use.

The apparatus 56 further includes a punch 66 defining a plurality of cutting surfaces 68, each corresponding in shape and position to a respective notch 24 and aperture 26. As shown in FIG. 5, the punch 56 is drivingly connected to drive source 70, such as a hydraulic cylinder, and is movable into and out of engagement with the bi-metal strip seated on the work support surface 62 for cutting the notches 24 and aperture 26 in the bi-metal strip. As will be recognized by those of ordinary skill in the pertinent art based on the teachings herein, the scoring tool 58 and punch 66 may be computer-controlled to automatically drive the scoring tool and punch into and out of engagement with the bi-metal strip, and a driving mechanism (not shown) may be employed to automatically index the bi-metal strip relative to the scoring tool and punch. Similarly, the scoring tool and punch may be mounted in different apparatus or work stations than each other, and/or may each take the form of any of numerous other tools that are currently or later become known for either applying the score lines to the bi-metal strip, or cutting the notches and/or apertures in the bi-metal strip. For example, as described above, a progressive die may be employed to punch the registration apertures and notches and to form the score lines. In addition, as described further below, at step 118 of FIG. 3B, the high speed or tool steel cutting edges of the blades may be notched at the juncture of each score line and the cutting edge to facilitate

WO 03/009978

PCT/US02/23800

separation of the blades from the composite strip and to shape the corners of the cutting edges of the blades.

As shown at step 120 of FIG. 3B, the punched and scored bi-metal strip 46 may be coiled again, if necessary, for either temporary storage or transportation to the hardening and tempering stations. At step 122, the bi-metal strip is then uncoiled, if necessary, and at step 124, the uncoiled strip is hardened and tempered. As may be recognized by those of ordinary skill in the pertinent art based on the teachings herein, the hardening and tempering operations may be performed in accordance with any of numerous different hardening and tempering processes and apparatus that are currently known, or later become known for hardening and tempering articles like the bi-metal strip 46. In the currently preferred embodiment of the present invention, the bi-metal strip 46 is hardened at a temperature within the range of approximately 2000° F to approximately 2200° F for a hardening time period within the range of about 3 to about 5 minutes. Then, after hardening, the bi-metal strip is tempered within a first tempering cycle at a temperature within the range of approximately 1000° F to approximately 1200° F for a tempering time within the range of about 3 to about 5 minutes. After the first tempering cycle, the bi-metal strip is quenched by air cooling to room temperature. In the currently preferred embodiment of the present invention, the hardening and tempering cycles are performed "in-line" such that the bi-metal strip is continuously driven first through an elongated hardening furnace, then through a first elongated tempering furnace, then through a quenching station, and then through at least one more tempering furnace and quenching station. However, as may be recognized by those of ordinary skill in the pertinent art based on the teachings herein, the bi-metal strip may be repeatedly passed through the same tempering furnace and quenching station(s), and/or may be wound into coils and hardened, tempered and quenched in a "pit-type" or other furnace. In addition, the quenching may be an air quench as described herein, or may be an oil quench or other type of quench that is currently, or later becomes known for quenching tempered articles of the type disclosed herein. Similarly, the composite strip may be subjected to any number of tempering and quenching cycles as may be required in order to obtain the desired physical characteristics of the resulting blades.

At step 126, the tempered and quenched bi-metal strip 46 is coiled again, if necessary, for transportation to the next tempering station, and at step 128, the bi-metal strip is uncoiled for the second tempering cycle. As discussed above, these and other coiling and uncoiling steps can be eliminated by providing one or more in-line stations for processing

WO 03/009978

PCT/US02/23800

the bi-metal strip. At step 130, the bi-metal strip is tempered again within a second tempering cycle at a temperature within the range of approximately 1000° F to approximately 1200° F for a tempering time within the range of about 3 to about 5 minutes. After the second tempering cycle, the bi-metal strip is quenched to room temperature. In the currently preferred embodiment, the quench is an air quench; however, as discussed above, this quench may take the form of any of numerous other types of quenching processes that are currently or later become known for articles of the type disclosed herein. Then, at step 132 the tempered and quenched bi-metal strip is coiled again either for temporary storage and/or transportation to the grinding, die cutting or bending and snapping stations.

At step 134, the annealed, hardened and tempered bi-metal strip 46 is uncoiled again, if necessary, and at 136, the bi-metal strip is subjected to grinding, honing, stropping, and die-cutting or bending and snapping steps. More specifically, the bi-metal strip 46 is ground, honed and stropped in a manner known to those of ordinary skill in the pertinent art to form the facets 30 and 32 of FIG. 2, and thereby define a straight, high-speed or tool steel cutting edge along the side of the composite strip opposite the back edge of the first metal portion. Then, the ground, honed and stropped bi-metal strip 46 is die cut, bent and snapped or otherwise separated along the score lines 64 of FIG. 5 to thereby form a plurality of utility knife blades from the composite strip. As described above, in the currently preferred embodiment of the present invention, each utility knife blade defines an approximately trapezoidal peripheral configuration with the notches 24 and central aperture 26 formed therein, as shown typically in FIG. 1, or otherwise as described below.

As shown in FIG. 6, a typical apparatus for die cutting the bi-metal strip is indicated generally by the reference numeral 72. The apparatus 72 comprises male and female dies 74 and 76, respectively, wherein the female die 76 is connected to a shaft 78 and the shaft is, in turn, drivingly connected to a hydraulic cylinder or like drive source 80 for moving the female die 78 into and out of engagement with the bi-metal strip 46 overlying the male die 74. The male die 74 includes a locator pin 82 projecting upwardly therefrom and received within the apertures 26 of the bi-metal strip to thereby properly locate the bi-metal strip between the male and female dies. As shown in phantom in FIG. 6, the female die 76 includes blade-like edges 84, and the male die 74 includes opposing blade-like edges 86 overlying and underlying respectively the score lines 64 of the portion of the bi-metal strip 46 received between the dies. Then, in order to die cut the strip, the drive source 80 is

WO 03/009978

PCT/US02/23800

actuated to drive the female die 76 downwardly and into engagement with the bi-metal strip such that the female and male blade-like edges 84 and 86, respectively, cooperate to shear the bi-metal strip along the score lines and thereby form a respective utility knife blade embodying the present invention, as shown typically in FIG. 1. During this die-cutting operation, because of the relative hardness of the first and second metal portions 20 and 22, respectively, of the bi-metal strip, the strip is sheared by the blade-like edges along the score lines 64 within the first metal portion 20, and is snapped by the blade-like edges along the portions of the score lines within the relatively hard and brittle second portion 22. Thus, the score lines provide desired break lines (or a desired "crack path") within the relatively hard and brittle second metal portion, and therefore are important to providing clean and sharp edges in these regions of the blades.

In accordance with an alternative embodiment of the present invention, and as shown typically in FIG. 7, the bi-metal strip 46 may be punched prior to hardening at step 124 in order to avoid the need to later cut the relatively hard and brittle high speed steel edge at step 136, and thereby prevent any possible damage to the cutting edge 14 and facets 30 and 32 formed thereon that might otherwise occur during die-cutting. As shown typically in FIG. 7, an apparatus for punching the high-speed steel edge in accordance with the present invention is indicated generally by the reference numeral 88. The apparatus 88 includes a punch or like tool 90 mounted on a tool support 92 over a work support surface 94 for supporting the bi-metal strip 46 thereon. The tool support 92 is drivingly connected to a hydraulic cylinder or like drive source 96 for driving the punch 90 into and out of engagement with the high speed steel edge 14 of the bi-metal strip 46. As shown typically in FIG. 7, the punch 90 is shaped and configured to form a notch 98 at the interface of each score line 64 and the high speed steel edge or second metal portion 22. Thus, as shown typically in FIG. 7, each notch 98 may extend along the respective score line throughout the second metal portion 22 of the score line to thereby separate the high speed steel portion of the respective blade from the remainder of the bi-metal strip at the score lines.

Alternatively, as described further below, each score line may extend along only a portion of the lateral extent of the second metal portion to facilitate cleanly separating the blades from the composite strip and/or to shape the corners of the cutting edges. Then, when the bi-metal strip 46 is die cut as shown in FIG. 6, or bent and snapped as described below, the equipment need only cut or snap the first metal portion 20 of the strip along the score lines and need not cut or snap the high speed steel edge portions removed by the notching

WO 03/009978

PCT/US02/23800

operation. As described above, the first metal portion 20 is relatively pliable and significantly less hard than the second metal portion 22, and therefore the first metal portion 20 may be easily and cleanly die cut, bent and snapped, or otherwise separated along the score lines 64. After hardening, the second metal portion 22 may be relatively difficult to die cut because of the relative hardness and brittleness of this portion. However, prior to hardening, the high speed steel edge exhibits a surface hardness within the range of about 25 Rc, and therefore may be relatively easily and cleanly cut at this stage of the process. Accordingly, the alternative process and construction of FIG. 7 may facilitate the ability to avoid any damage to the hardened, high speed steel edge, that might otherwise occur when die cutting such edge.

The notches 98 of FIG. 7 are shown as v-shaped notches. However, as may be recognized by those of ordinary skill in the pertinent art based on the teachings herein, these notches or cut outs may take any of numerous different shapes that may be required to separate the high speed steel edge portions of each blade from the remainder of the composite strip at the score lines. Similarly, as described further below, the notches may be formed to shape the corners of the cutting edges to be squared, oblique, or any other desired shape. As may be further recognized by those skilled in the pertinent art based on the teachings herein, it may be possible in the alternative embodiment of the present invention to eliminate the score lines because the score lines may be unnecessary in certain circumstances for purposes of die cutting the first metal portion 20 of the bi-metal strip.

Turning again to FIG. 3B, at step 138 the blades are stacked, and at step 140, the stacked blades are packaged in a manner known to those of ordinary skill in the pertinent art.

Turning to FIGS. 8 and 9, an apparatus for bending and snapping the composite strips 46 in order to form the utility knife blades 10 is indicated generally by the reference numeral 142. The apparatus 142 includes a blade support 144, a drive assembly 146 mounted on one side of the blade support, and a blade magazine 148 mounted on the opposite side of the blade support relative to the drive assembly 146. The drive assembly 146 includes a drive plate 147 mounted on linear bearings (not shown) and drivingly connected to a suitable drive source, such as a hydraulic or pneumatic cylinder (not shown), for moving the drive plate toward and away from the blade support 144 as indicated by the arrows in FIG. 8. The drive assembly 146 further includes a first bending pin 150 slidably received through a first pin aperture 152 extending through the blade support 144; a second

WO 03/009978

PCT/US02/23800

bending pin 154 slidably received through a second pin aperture 156 extending through the blade support; a first breaking punch 158 including a support shaft 160 slidably received through a first punch aperture 162 extending through the blade support; and a second breaking punch 164 including a support shaft 166 slidably received through a second punch aperture 168. The first breaking punch 158 includes a first blade release pin 170, and the second breaking punch 164 includes a second blade release pin 172. As described further below, each blade release pin 170 and 172 is spring loaded in the direction out of the page in FIG. 9. Accordingly, upon bending and snapping each blade 10 from the composite strip 46, the spring loaded pins 170 and 172 drive the respective blade 10 into the blade magazine 148. The apparatus 142 further includes a spring-loaded presser plate 174 for pressing the composite strip 46 against the blade support 144. The presser plate 174 is mounted on a shaft 176 slidably received through an aperture 178 formed in a support block 180 for movement toward and away from the blade support, as indicated by the arrows in FIG. 8. A coil spring 182 or like biasing member is coupled to the presser plate 174 and support shaft 176 to normally bias the presser plate toward the blade support. As shown in FIG. 8, the blade magazine 148 is spaced away from the blade support 144 to thereby define a blade gap 184 therebetween. The composite strip 46 is fed through the blade gap 184 in the direction from the right-hand to the left-hand side in each of FIGS. 8 and 9. The surface 186 of the blade magazine 148 facing the blade support 144 defines a rule or die against which the composite strip is pressed for performing the bending and snapping operation.

In FIG. 10, the composite strip 46 that is bent and snapped in the apparatus 142 includes registration apertures 26 formed in the scrap portion of the strip, i.e., between the score lines 64 of adjacent blades 10. In addition, the composite strip 46 includes a plurality of notches 98 formed in the second metal portion 22 at the juncture of each score line 64 and the second metal portion. As can be seen in FIG. 10, each notch 98 extends laterally into the second metal portion 22 about half-way across the width of the second metal portion. In addition, the end surfaces of each notch in the axial direction of the composite strip are each oriented approximately normal to the cutting edge (i.e., each notch is approximately rectangular). In this manner, when the composite strip is bent and snapped and the blades are separated therefrom as described further below, the corners of each cutting edge 14 are squared. The depth of each notch 98 (i.e., the lateral dimension on the composite strip) is sufficient to remove from the strip the respective portion of the cutting edge 14 that does not define a score line 64, and that contains any portion of the respective

WO 03/009978

PCT/US02/23800

score line that is too shallow due to the sloped configuration of the facets 30, 32 to effectively bend and snap the blade from the strip and thereby define a clean corner (i.e., a straight edge or otherwise an edge defined by a clean break along the respective score line). Accordingly, a significant advantage of the notches 98 is that they facilitate forming a clean break at the corners of the cutting blades. In addition, by shaping the corners of the cutting edge to define a squared edge, a rounded edge, an oblique edge, or other desired shape, the corners of the blade can be made significantly more robust in comparison to pointed corners, and thus less susceptible to chipping and/or breaking in comparison to pointed corners. As may be recognized by those skilled in the pertinent art based on the teachings herein, the notches may take any of numerous different shapes, configurations and/or sizes that may be desired to facilitate the manufacture and/or to enhance performance of the blades, or otherwise as desired. As described above, the notches 98 are preferably formed at step 118 of FIG. 3B in a progressive die or other suitable tool or equipment.

In the operation of the bending and snapping apparatus 142, the composite strip 46 is fed through the blade gap 184 of the apparatus in the direction of the arrow C of FIG. 10, i.e., from the right-hand to the left-hand side in each of FIGS. 8-10. First, the composite strip 46 is secured in place by a locating pin (not shown) received within a respective registration aperture 26. Then, the drive assembly 142 is driven toward the blade support 144, and the first and second bending pins, 150 and 154, respectively, and the first and second breaking punches 158 and 164, respectively, are configured to successively bend and break the composite strip about each score line as hereinafter described. Initially, the first bending pin 150 is driven by the drive assembly 142 against the strip to bend the first triangle 188 of FIG. 10 about the respective score line 64, i.e., in the direction out of the page in FIG. 10. As can be seen, the portions of the composite strip 46 defining the respective score lines 64 are driven against the die 186 to thereby bend the respective triangle about the die and score line, and away from the blade support 144. While the first bending pin 150 is bending the first triangle 188 outwardly, the first breaking punch 158 is pressed against the blade to simultaneously apply pressure to the composite strip 46 on the opposite side of the respective score line 64 relative to the first bending pin 150. Next, the second bending pin 154 is driven against the composite strip 46 at the second triangle 190 of FIG. 10 to, in turn, bend the second triangle outwardly around the respective score line, i.e., out of the page in FIG. 10. While the second bending pin 154 is bending the second triangle 190 outwardly, the second breaking punch 164 is pressed against the composite

WO 03/009978

PCT/US02/23800

strip to simultaneously apply pressure to the composite strip on the opposite side of the respective score line 64 relative to the second bending pin 154. The first breaking punch 158 then snaps the composite strip at the respective score line 64 and the first triangle 188 falls downwardly away from the blade. Then, the second breaking punch 164 snaps the composite strip at the respective score line 64, and the spring-loaded pins 170 and 172 drive the resulting blade 10 outwardly into the blade magazine 148. The drive assembly 142 is then driven rearwardly, i.e., away from the blade support 144, the spring loaded presser plate 174 presses and, in turn, bends the second triangle 190 of the composite strip inwardly against the blade support 144 to thereby straighten the respective portion of the strip and allow its subsequent passage through the blade gap 184, and the composite strip 46 is indexed forwardly through the blade gap to present the next blade section of the composite strip for bending and snapping in the manner described above. This process is repeated for each blade section until all blades 10 are bent and snapped away from the composite strip 46. As may be recognized by those of ordinary skill in the pertinent art based on the teachings herein, the bending pins and breaking punches may take any of numerous different shapes and/or configurations that are currently, or later become known for performing the functions of these components as described herein. For example, as shown in phantom in FIG. 8, the ends of the bending pins may be defined by angled surfaces to facilitate the bending operation. Similarly, the breaking punches may define angled or other surfaces to facilitate pressing and snapping the blades without damaging them.

As shown in FIG. 8, the blade magazine 148 includes an adjustable blade support 192 that is slidably mounted within the magazine, and the support 192 includes an adjustment knob 194 for fixedly securing the position of the blade support within the magazine. As the blades 10 are bent and snapped away from the composite strip 46, they are stacked by the spring-loaded pins 170 and 172 against the blade support 192. The drive assembly 142 further includes a blade guard 196 overlying the bending and snapping region of the apparatus 142 to prevent upward movement of the blades and retain them within the magazine.

As may be recognized by those skilled in the pertinent art based on the teachings herein, numerous changes and modifications may be made to the abovedescribed and other embodiments of the composite utility knife blades and the methods of making such blades of the present invention without departing from the scope of the invention as defined in the appended claims. For example, as shown in FIGS. 11A-11D, the blade 10 may take any of

WO 03/009978

PCT/US02/23800

numerous different shapes and/or configurations. As shown in FIG. 11A, the cutting edge 14 of the trapezoidal blade 10 may define squared corners formed by the notches 98 described above with reference to FIG. 10. In FIG. 11B, the cutting edge 14 of the blade may define rounded corners by forming correspondingly shaped notches 98 in the composite strip 46. Alternatively, as shown in dashed lines in FIG. 11B, the blade 10 may define a rectangular shape, or as shown in the dashed-dotted lines, the blade may define a parallelogram. In FIG. 11C, the blade 10 defines a plurality of parallelogram-shaped segments separated by score lines 64 and respective notches 98. The notches 98 extend laterally into each second metal portion in the same manner as the notches 98 described above with reference to FIG. 10. The blade 10 of FIG. 11C is designed for use in a "snap-off" blade holder of a type known to those of ordinary skill in the pertinent art whereby each parallelogram-shaped segment (or other shaped segment, if desired) may be snapped off when the respective cutting edge segment 14 becomes worn to, in turn, expose a fresh cutting edge segment. Similarly, although the composite utility knife blades 10 described above define a bi-metal construction, the blades of the present invention may equally define a tri-metal or other composite construction. For example, as shown in FIG. 11D, the utility knife blades of the present invention may define high speed or tool steel cutting edges 14, 14' (the second cutting edge 14' being shown in broken lines) formed on opposite sides of the blade relative to each other, with a relatively tough, spring-like portion formed between the outer high speed steel edges. Similarly, a tri-metal strip may be cut down the middle, or otherwise cut along an axially-extending line to form two bi-metal strips which each may, in turn, be cut to form the blades of the present invention. As also shown in FIG. 11D, the corners of the cutting edges 14, 14' may be formed by lateral surfaces oriented at oblique angles relative to the cutting edge.

In addition, many, if not all, of the coiling and uncoiling steps shown in FIGS. 3A and 3B may be eliminated by employing in-line processing apparatus. Also, the blades first may be blanked from the composite strip, such as by die-cutting or bending and snapping, and then the heat treating, grinding and other finishing steps may be performed on the blanked blades to form the final utility knife blades. Accordingly, this detailed description of preferred embodiments is to be taken in an illustrative, as opposed to a limiting sense.

WO 03/009978

PCT/US02/23800

What is claimed is:

1. A composite utility knife blade, comprising:
a first edge, a second edge, a third edge located on an opposite side of the blade
relative to the second edge, and a fourth edge defining at least one cutting edge located on
5 an opposite side of the blade relative to the first edge;
first and second metal portions, wherein the first metal portion extends between the
first edge and the second metal portion, and extends between the second edge and the third
edge, and is formed of a steel heat treated to a hardness within the range of approximately
38 Rc to approximately 52 Rc, and the second metal portion defines the cutting edge and
10 extends between the second edge and the third edge, and is formed of a tool steel heat
treated to a hardness within the range of approximately 60 Rc to approximately 75 Rc; and
a weld region joining the first and second metal portions and extending between the
second edge and the third edge of the blade.
- 15 2. A composite utility knife blade as defined in claim 1, wherein the second metal
portion consists essentially of high speed tool steel.
3. A composite utility knife blade as defined in claim 1, wherein the first, second,
third and fourth edges of the blade define one of an approximately trapezoidal shape, an
20 approximately rectangular shape, and an approximately parallelogram shape.
4. A composite utility knife blade as defined in claim 1, wherein the at least one
cutting edge defines a straight edge.
- 25 5. A composite utility knife blade as defined in claim 1, further defining at least one
notch formed in the back edge.
6. A composite utility knife blade as defined in claim 4, wherein the cutting edge
defines an approximately straight edge extending from approximately the second edge to
30 approximately the third edge of the blade, and at least two facets formed on opposite sides
of the blade relative to each other.

WO 03/009978

PCT/US02/23800

7. A composite utility knife blade as defined in claim 1, wherein the interface of the first and second metal portions defines a butt joint forming an approximate line of joinder within the weld region.

5 8. A composite utility knife as defined in claim 1, further defining a corner at each end of the cutting edge, wherein each corner is formed by a surface that is one of (i) rounded, (ii) oriented approximately perpendicular to the cutting edge, and (iii) oriented at an oblique angle to the cutting edge.

10 9. A composite utility knife blade as defined in claim 1, further comprising another second metal portion formed of a tool steel heat treated to a hardness within the range of approximately 60 Rc to approximately 75 Rc and located on the opposite side of the first metal portion relative to the other second metal portion, and wherein the fourth edge defines a first cutting edge, and the first edge defines a second cutting edge located on an opposite
15 side of the blade relative to the first cutting edge.

20 10. A composite utility knife blade as defined in claim 1, further defining a plurality of score lines axially spaced relative to each other and a plurality of notches, wherein a plurality of the notches are each formed at a juncture of a respective score line and the second metal portion to facilitate bending and snapping a respective cutting segment from the blade.

25 11. A composite utility knife blade as defined in claim 1, wherein the composite utility knife blade is made in accordance with a method comprising the following steps:
providing an elongated wire formed of wear-resistant steel, and an elongated backing strip formed of steel and defining a first side, a second side, and opposing lateral edges extending between the first and second sides;
placing the wire in contact with a lateral edge of the backing strip;
applying thermal energy to the interface between the wire and backing strip to weld
30 the wire to the backing strip and, in turn, forming a composite strip defining a first metal portion formed by the steel backing strip, a second metal portion formed by the wear-resistant steel wire, and a weld region joining the first and second metal portions;
heat treating the composite strip;

WO 03/009978

PCT/US02/23800

forming at least one facet into the second metal portion and, in turn, forming an approximately straight wear-resistant steel cutting edge along the side of the composite strip; and

5 separating the composite strip at a plurality of axially spaced locations to thereby form a plurality of composite utility knife blades from the composite strip.

12. A composite utility knife blade as defined in claim 11, wherein the method of making the composite utility knife blade further includes the steps of:

10 scoring the composite strip at axially spaced locations relative to each other to form a plurality of score lines defining a plurality of blade sections therebetween; and
separating the composite strip at a plurality of the score lines to thereby form the plurality of composite utility knife blades from the composite strip.

13. A composite utility knife blade as defined in claim 11, wherein the heat treating step of the method of making the composite utility knife blade includes:

hardening the composite strip;
tempering the hardened composite strip; and
quenching the hardened composite strip.

20 14. A composite utility knife blade as defined in claim 12, wherein the method of making the composite utility knife blade further comprises the step of forming a plurality of notches axially spaced relative to each other in the second metal portion of the composite strip, wherein a plurality of the notches are each formed at a juncture of a respective score line and the second metal portion for at least one of facilitating separation of the blades
25 from the composite strip and defining the shapes of the corners of the cutting edges of the blades.

15. A composite utility knife blade as defined in claim 14, wherein a plurality of the notches each extend laterally into the second metal portion of the cutting edge a depth
30 sufficient to remove from the strip a respective portion of the cutting edge that does not define a score line.

WO 03/009978

PCT/US02/23800

16. A composite utility knife blade as defined in claim 12, wherein the step of separating the composite strip to form a plurality of utility knife blades includes at least one of:

- (i) bending and snapping the composite strip at a plurality of the score lines to thereby separate the blades from the composite strip; and
- (ii) die cutting the composite strip at a plurality of the score lines to thereby separate the blades from the composite strip.

17. A composite utility knife blade as defined in claim 16, wherein the step of separating the composite strip to form a plurality of utility knife blades further includes forming a plurality of notches axially spaced relative to each other in the second metal portion of the composite strip, wherein a plurality of the notches are each formed at a juncture of a respective score line and the second metal portion.

18. A composite utility knife blade as defined in claim 11, wherein the step of separating the composite strip to form a plurality of utility knife blades includes at least one of:

- (i) die cutting the composite strip at a plurality of axially spaced locations to separate the blades from the composite strip; and
- (ii) blanking the composite strip into a plurality of separate blade segments, and heat treating and forming the cutting edges in the separate blade segments.

19. A composite utility knife blade as defined in claim 18, wherein step (i) further includes forming a plurality of notches axially spaced relative to each other in the second metal portion of the composite strip; and step (ii) further includes annealing the composite strip prior to blanking.

20. A composite utility knife blade, comprising:
a first edge, a second edge, a third edge located on an opposite side of the blade relative to the second edge, and a fourth edge defining at least one cutting edge located on an opposite side of the blade relative to the first edge;

WO 03/009978

PCT/US02/23800

first means for forming a wear-resistant cutting edge defining a hardness within the range of approximately 60 Rc to approximately 75 Rc and extending from approximately the second edge to approximately the third edge;

second means for forming a spring-like backing to the first means and defining a
5 hardness within the range of approximately 38 Rc to approximately 52 Rc, said second means extending between the first edge and the first means and extending from approximately the second edge to approximately the third edge; and

a weld region joining the first and second means and extending from approximately the second edge to approximately the third edge of the blade.

10

21. A composite utility knife blade as defined in claim 20, wherein the interface of the first and second means defines a butt joint forming an approximate line of joinder within the weld region.

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22. A composite utility knife as defined in claim 20, wherein the first means defines an approximately straight cutting edge extending from approximately the second edge to approximately the third edge of the blade.

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23. A composite utility knife as defined in claim 22, wherein the cutting edge defines at least two facets located on opposite sides of the blade relative to each other.

25

24. A composite utility knife blade as defined in claim 20 wherein the first means is formed of a tool steel wire welded to the second means and heat treated to a hardness within the range of approximately 60 Rc to approximately 75 Rc.

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25. A composite utility knife blade as defined in claim 20, wherein the second means is formed of an alloy steel strip welded to the first means and heat treated to a hardness within the range of approximately 38 Rc to approximately 52 Rc.

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26. A method of making composite utility knife blades, wherein each blade comprises a first edge, at least one a cutting edge located on an opposite side of the blade relative to the first edge, a second edge, a third edge located on an opposite side of the blade relative to the second edge; first and second metal portions, wherein the first metal portion

WO 03/009978

PCT/US02/23800

forms a spring-like backing extending between the first edge and the first metal portion and further extending between the second edge and the third edge, and the second metal portion defines the cutting edge and extends between the second edge and the third edge; and a weld region joining the first and second metal portions and extending from approximately the second edge to approximately the third edge of the blade, the method comprising the steps of:

- providing an elongated wire formed of wear-resistant steel, and an elongated backing strip formed of steel and defining a first side, a second side, and opposing edges extending between the first and second sides;
- placing the wire in contact with an edge of the backing strip;
- applying thermal energy to the interface between the wire and backing strip to weld the wire to the backing strip and, in turn, forming a composite strip defining a first metal portion formed by the steel backing strip, a second metal portion formed by the wear-resistant steel wire, and a weld region joining the first and second metal portions;
- heat treating the composite strip;
- forming at least one facet into the second metal portion and, in turn, forming an approximately straight wear-resistant steel cutting edge along the side of the composite strip; and
- scoring the composite strip at axially spaced locations relative to each other to form a plurality of score lines, wherein a plurality of the score lines define a plurality of blade sections and scrap sections located between the blade sections;
- bending at least one scrap section outwardly relative to a plane of the composite strip on one side of a respective score line; and
- pressing the composite strip on an opposite side of the respective score line and, in turn, breaking the blade section away from the bent scrap section along the respective score line.

27. A method of making composite utility knife blades as defined in claim 26, wherein the heat treating includes:
- annealing the composite strip;
 - hardening the annealed composite strip;
 - tempering the hardened composite strip; and
 - quenching the hardened composite strip.

WO 03/009978

PCT/US02/23800

28. A method of making composite utility knife blades as defined in claim 27, further comprising the step of straightening the annealed composite strip.

5 29. A method of making composite utility knife blades as defined in claim 26, wherein the steps of bending the composite strip on one side of a score line, pressing the composite strip on the opposite side of the score line and, in turn, breaking the composite strip along the score line, are repeated for a plurality of score lines to thereby form a plurality of blades from the composite strip.

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30. A method of making composite utility knife blades as defined in claim 26, wherein the blade sections are approximately trapezoidal and each scrap section is approximately triangular.

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31. A method of making composite utility knife blades as defined in claim 26, wherein the step of scoring the composite strip includes scoring the composite strip to a depth of about 40% to about 50% of the thickness of the composite strip.

20

32. A method of making composite utility knife blades as defined in claim 31, wherein the step of scoring the composite strip includes scoring the composite strip to a depth of about 45% to about 48% of the thickness of the composite strip.

25

33. A method of making composite utility knife blades as defined in claim 27, further comprising the steps of repeating at least once the steps of tempering and quenching the hardened composite strip.

30

34. A method of making composite utility knife blades as defined in claim 26, wherein the step of applying thermal energy to the interface of the wire and backing strip includes electron beam welding the wire to the backing strip.

35. A method of making composite utility knife blades as defined in claim 26, further comprising the steps of:

WO 03/009978

PCT/US02/23800

forming a plurality of registration apertures extending through the first metal portion and axially spaced relative to each other; and

bending and snapping at least one of the first and second metal portions with reference to the registration apertures by inserting a positioning device in at least one
5 aperture to position the composite strip relative to a bending and snapping apparatus.

36. A method of making composite utility knife blades as defined in claim 26, wherein the first metal portion is hardened to define a surface hardness within the range of approximately 38 Rc to approximately 52 Rc.

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37. A method of making composite utility knife blades as defined in claim 26, wherein the second metal portion is hardened to define a surface hardness within the range of approximately 60 Rc to approximately 75 Rc.

15 38. A method of making composite utility knife blades as defined in claim 26, further comprising the steps of:

butt joining a second wear-resistant steel wire to the other edge of the backing strip; applying thermal energy to the interface of the second wire and backing strip to weld the second wire to the backing strip; and

20 forming at least one facet in the wear-resistant steel edge formed by the second wire to, in turn, form a second approximately straight wear-resistant steel cutting edge along the side of the composite strip opposite the other cutting edge.

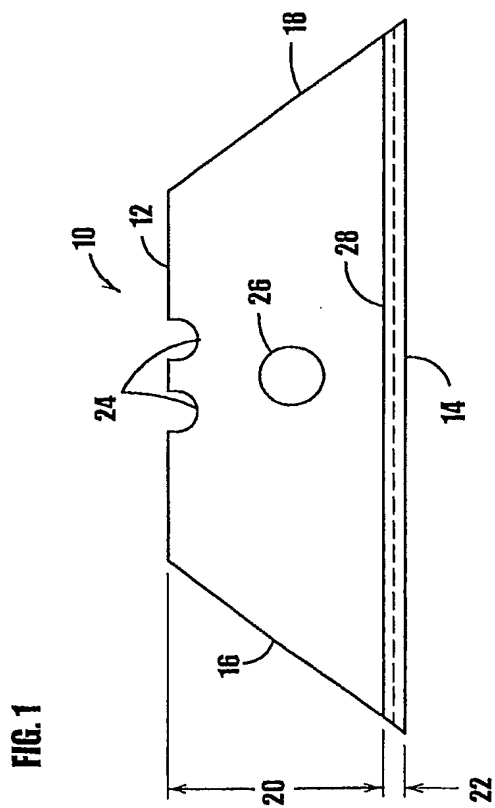
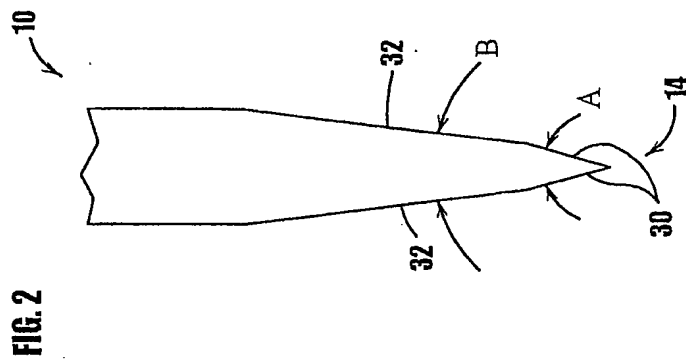
39. A method of making composite utility knife blades as defined in claim 26, wherein the step of scoring the composite strip includes forming a score line defining an included angle with the range of about 50° to about 60°.

40. A method of making composite utility knife blades as defined in claim 26, further comprising the step of forming a plurality of notches axially spaced relative to each
30 other in the second metal portion of the composite strip, wherein a plurality of the notches are each formed at a juncture of a respective score line and the second metal portion

WO 03/009978

1/12

PCT/US02/23800



WO 03/009978

2/12

PCT/US02/23800

FIG. 3A

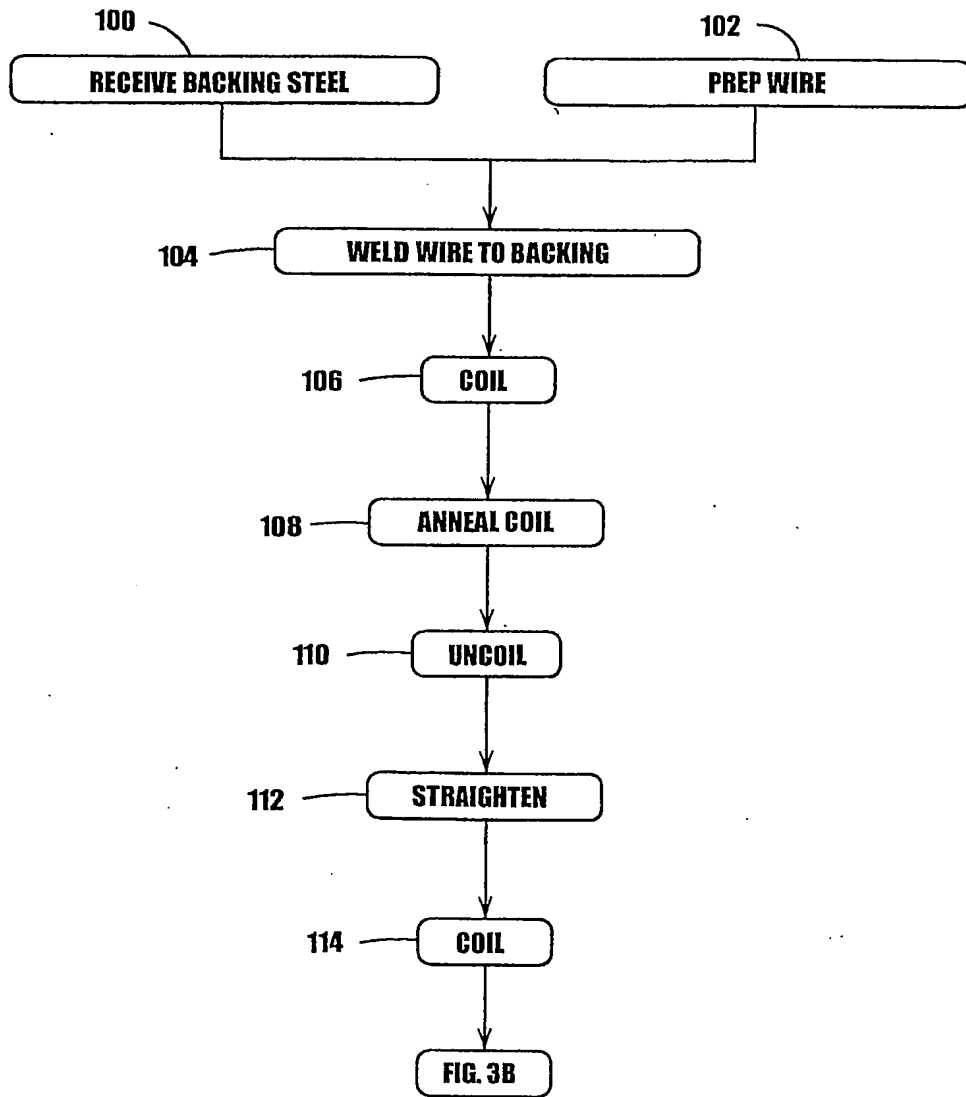
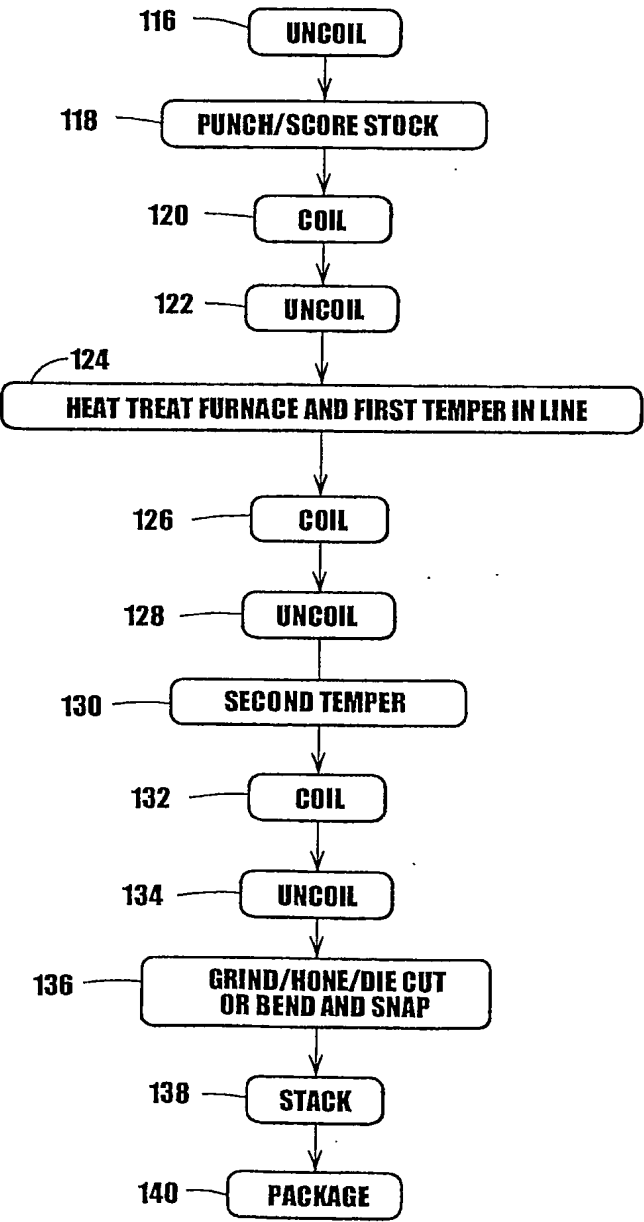


FIG. 3B

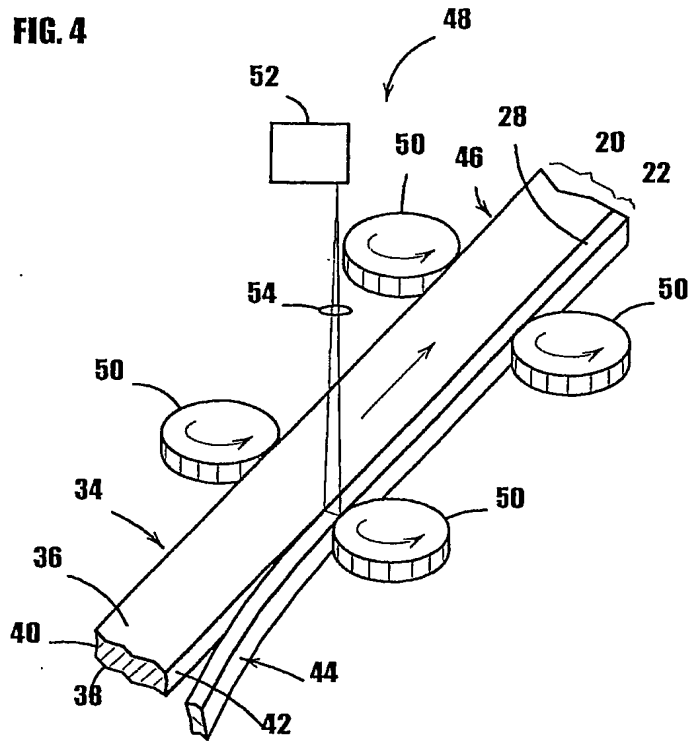


WO 03/009978

4/12

PCT/US02/23800

FIG. 4

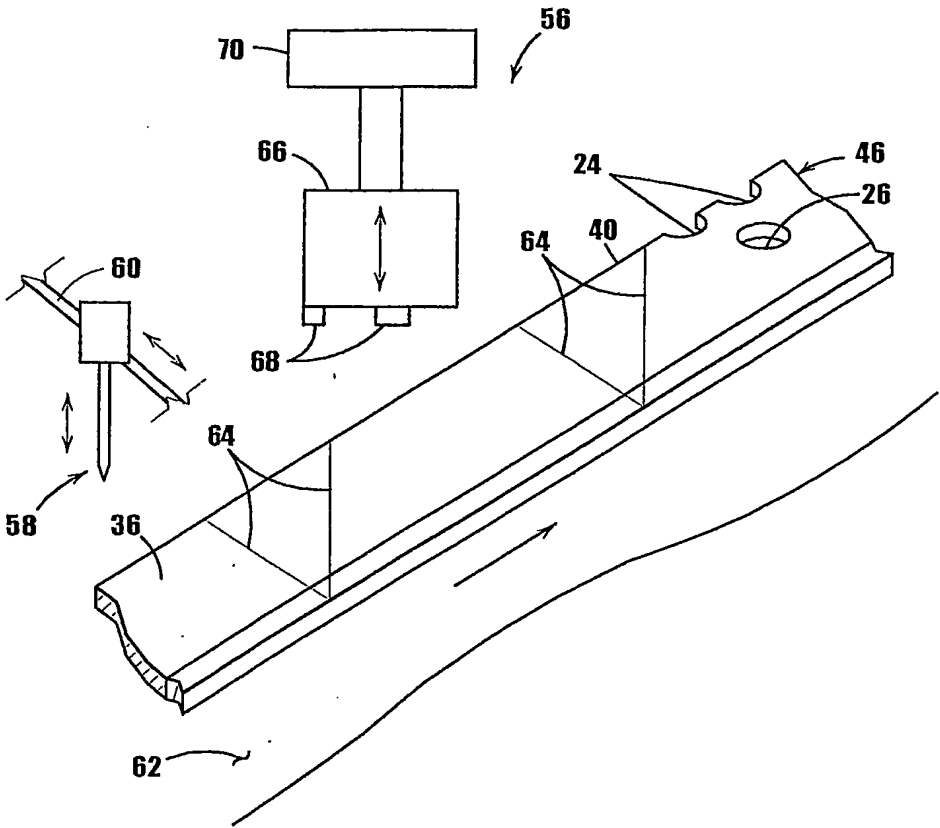


WO 03/009978

5/12

PCT/US02/23800

FIG. 5

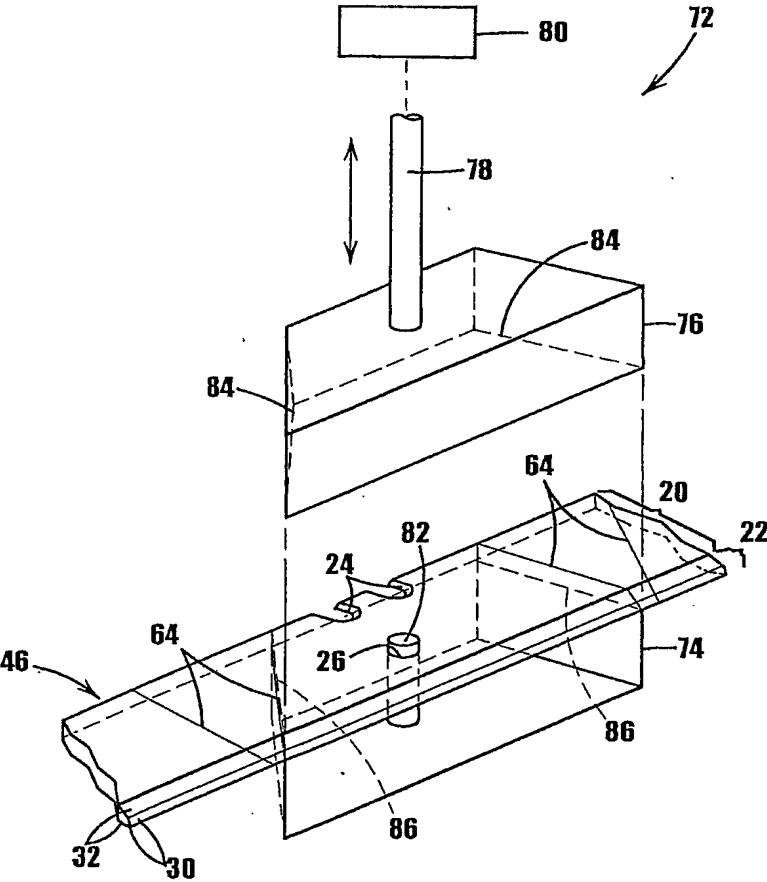


WO 03/009978

6/12

PCT/US02/23800

FIG. 6

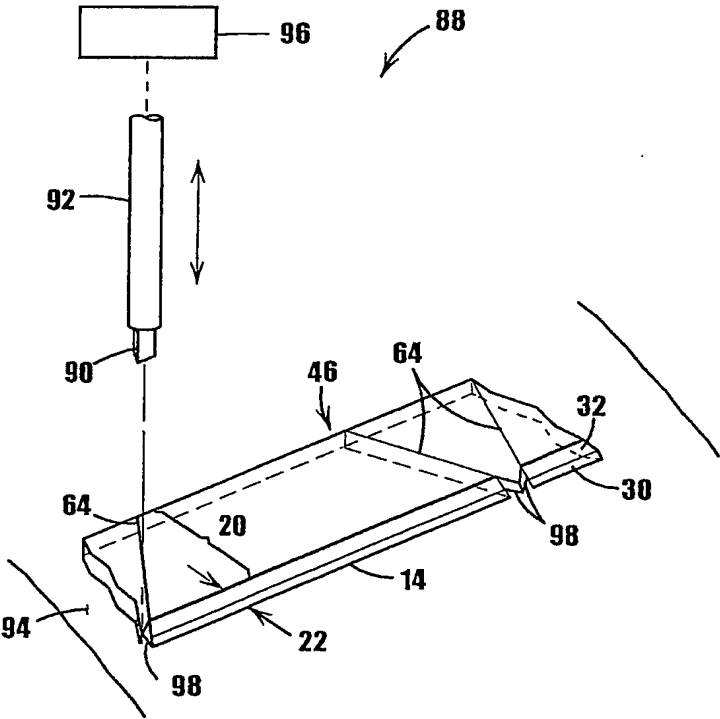


WO 03/009978

7/12

PCT/US02/23800

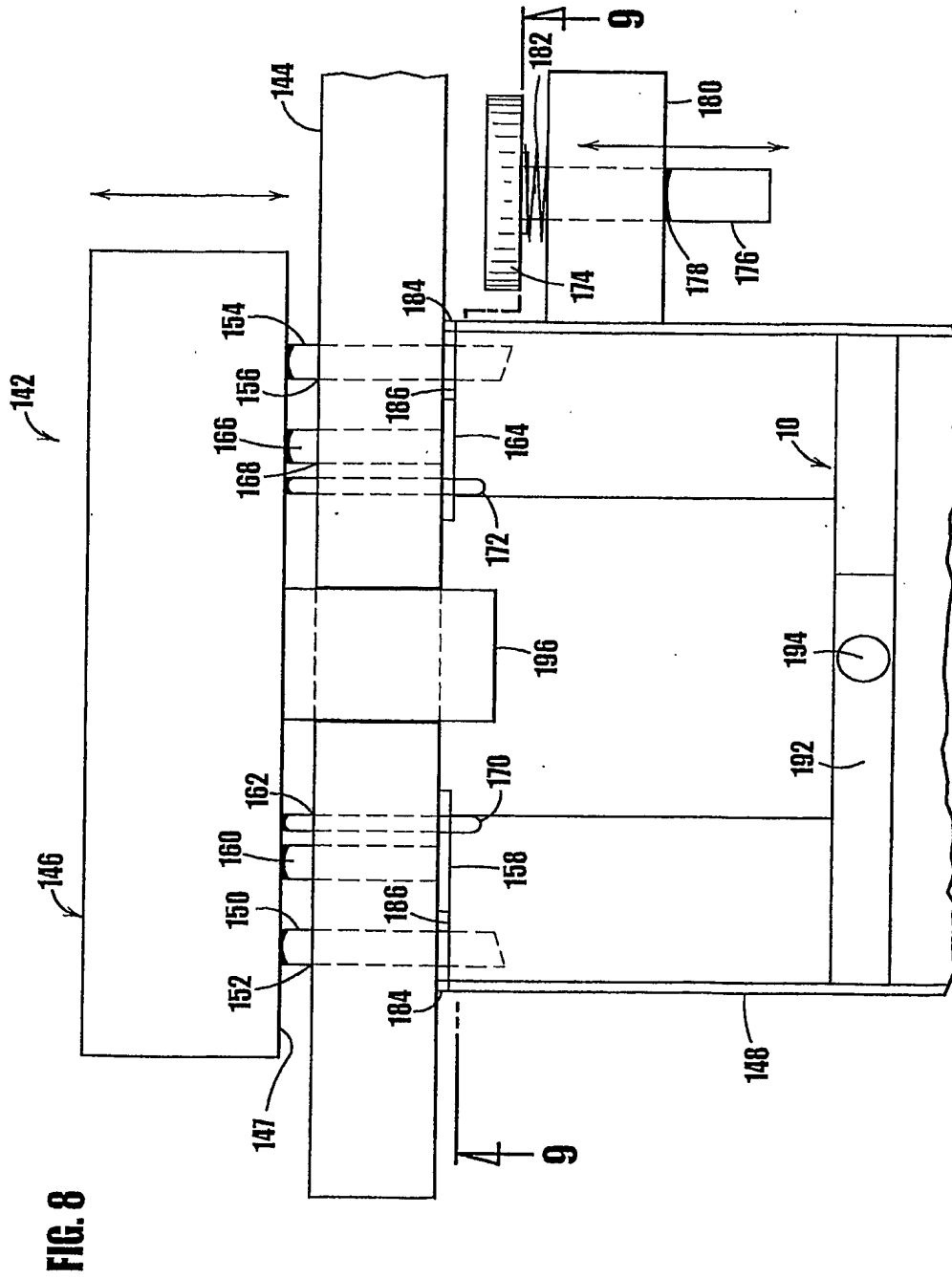
FIG. 7



WO 03/009978

8/12

PCT/US02/23800

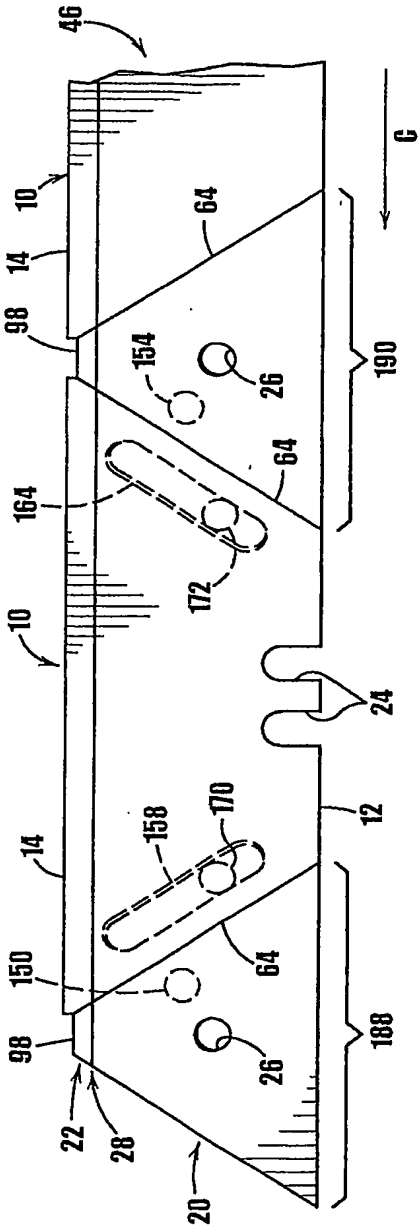


WO 03/009978

10/12

PCT/US02/23800

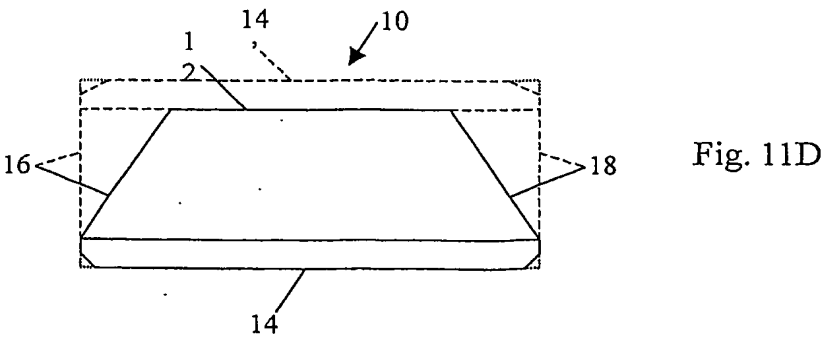
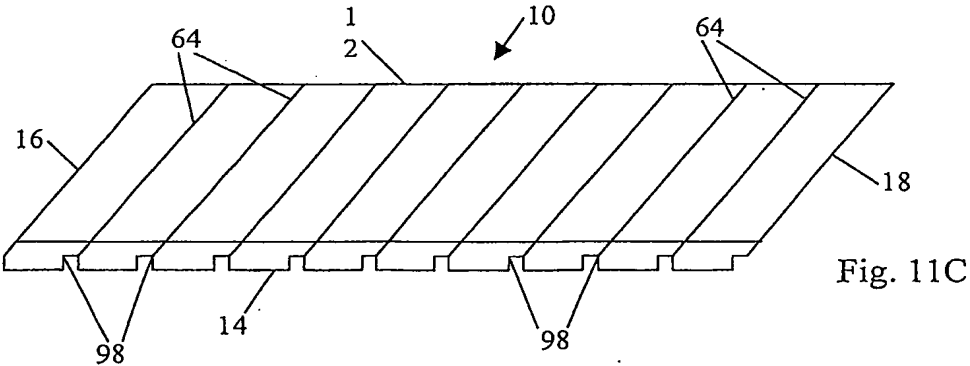
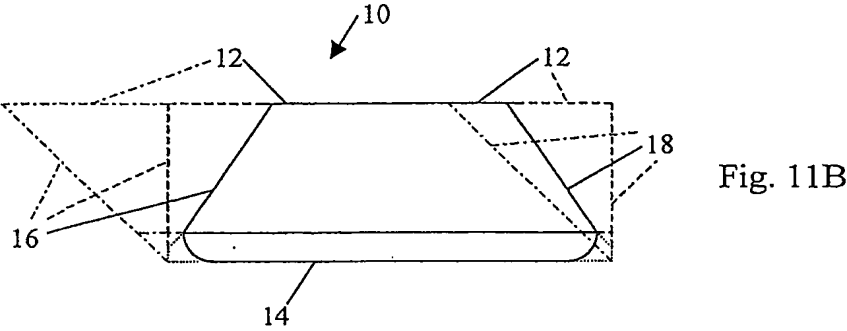
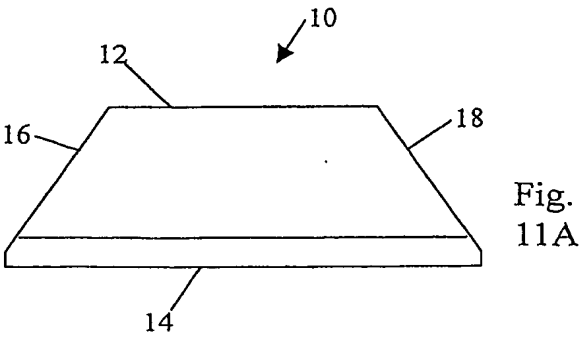
FIG. 10



WO 03/009978

11/12

PCT/US02/23800



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/23800

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B26B 21/54; B21K 11/00

US CL : 30/346.5, 350, 351, 353 ; 76/104.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 30/335, 346, 346.5, 346.53, 346.54, 30/346.57, 346.58, 346.61, 350, 351, 353 ; 76/104.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
none**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|---|-----------------------|
| Y | US 882,413 A (PARKISON) 17 March 1908 (17.03.1908), see Fig.3. | 14,15,19 |
| Y | US 1,734,554 A (BEHRMAN) 05 November 1929 (05.11.1929), see Figs.2-3 and 5-6. | 10, 12 and 16-18 |
| Y | US 3,315,548 A (ANDERSON et al.) 25 April 1967 (25.04.1967), see the entire document. | 1-25 |
| A | | 26-40 |
| Y | US 4,109,380 A (ANDERSON) 29 August 1978 (29.08.1978), see Figs.2 and 3. | 1 and 9 |
| Y | US 5,613,300 A (SCHMIDT) 25 March 1997 (25.03.1997), see Fig.3. | 1-8, 11, 13 and 20-25 |

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search

18 September 2002 (18.09.2002)

Date of mailing of the international search report

26 SEP 2002

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Form PCT/ISA/210 (second sheet) (July 1998)